

Foreign Patent Documents

Document No.: 2001-160497, published June 12, 2001

Country: Japan

Copy of reference: attached

Language: non-English

English translation: not attached because it is not readily available

Concise Explanation of Relevance: This document is disclosed in the body of a specification along with the statement of relevancy.

Document No.: 11-204280, published July 30, 1999

Country: Japan

Copy of reference: attached

Language: non-English

English translation: not attached because it is not readily available

Concise Explanation of Relevance:

[0053] A method of calculating a discharge current waveform $I_d(t)$ from the voltage waveform $E(t)$ and the current waveform $I_s(t)$ as shown in FIG. 11 will now be described.

[0054] The discharge current waveform $I_d(t)$ can be obtained by the formula below, by using the two coefficients: $F=1+C1/C2$

(formula 9); and $C_v = C1+C3 \cdot F$ (formula 10), which are determined by capacitance $C1$ of the capacitor 12 of the discharge plasma space 2, capacitance $C2$ of the capacitor 13 of the dielectrics 5 and 6, and a stray capacitance $C3$ existing parallel to the dielectric barrier discharge lamp.

$$I_d(t) = F \cdot I_s(t) - C_v \cdot dE(t)/dt \quad (\text{formula 11})$$

[0055] Since this method uses numerical differentiation, it does not have good accuracy in a small region of a current value, in the waveform obtained. However, since it shows a fast rise in start of discharge, it can be used with no problem as long as it is used for the purpose of finding the rise.

Applicant: Masami Kobayashi
Title: Discharge Lamp Starting Device and
Illumination Apparatus
U.S. Serial No. not yet known
Filed: October 23, 2003
Exhibit B

[0056] The following are the analytical conditions and experimental conditions in the case of FIGS. 9, 10 and 11.

C1: 35 pF

C2: 220 pF

C3: 15 pF

Frequency: 30 kHz

Transformer primary inductance: 1.1 mH

Transformer secondary inductance: 630 mH

Transformer coupling coefficient: 0.9993

Dielectric: silica glass – 1 mm thickness

Discharge gas: xenon – 33 kPa pressure

Discharge gap: 4.3 mm

[0057] In FIG. 11, the discharge current waveform $I_d(t)$ rises sharply at the time T_d . This shows that the time T_d is the time when discharge has started. In the voltage waveform $E(t)$, an inflection point K is formed at the point corresponding to the time T_d .

[0058] The voltage values V_k , V_b and V_h necessary for calculating the above values V_x and V_y are shown in FIG. 11, and the voltage value V_f is shown in FIG. 9. In this case, V_f has a negative value. Substituting their actual measured values into the (formula 1) yields $V_y/V_x = 0.30$.

[0059] Another embodiment will now be explained. FIG. 12 is a schematic circuit diagram of a lighting circuit of a dielectric barrier discharge lamp using an inverter circuit of full-wave bridge type. FIG. 13 illustrates actual measured data of the voltage waveform $E(t)$ and the current waveform $I_s(t)$ of the dielectric barrier discharge lamp 1 of FIG. 12. FIG. 14 is an enlarged view of the measured data of the section Z roughly shown in FIG. 13. FIG. 15 illustrates the discharge current waveform $I_d(t)$ obtained by analyzing the waveforms shown in FIG. 14 with a computer, together with the voltage waveform $E(t)$ and the current waveform $I_s(t)$.

[0060] The analytical conditions and experimental conditions in the case of FIGS. 13, 14 and 15 are the same as those in the case of FIGS. 9, 10 and 11, except that the frequency is 21 kHz. In

FIG. 11, around the time T_{a1} , the discharge current waveform $I_d(t)$ has no significant amplitudes, although the voltage waveform $E(t)$ and the current waveform $I_s(t)$ have a large amplitude around the time. This shows that no discharge is generated around the time T_{a1} under these experimental conditions. There are cases where discharge occurs in the point corresponding to the time T_{a1} according to the conditions, even in lighting of the same waveform.

[0061] In FIG. 15, the discharge current waveform $I_d(t)$ sharply rises at the time T_d . This shows that discharge started at the time T_d . In the voltage waveform $E(t)$, an inflection point K is formed at the point corresponding to the time T_d .

[0062] The voltage values V_k , V_b and V_h necessary for calculating the values V_x and V_y are shown in FIG. 11, and the voltage value V_f is shown in FIG. 13. In this case, the value V_f is negative. Substituting these actual measured values into the (formula 1) yields $V_y/V_x = 0.18$.

[0063] Another embodiment will now be explained. FIG. 16 is a schematic circuit diagram of a lighting circuit of a dielectric barrier discharge lamp using a flyback inverter circuit. FIG. 17 illustrates actual measured data of the voltage waveform $E(t)$ and the current waveform $I_s(t)$ of the dielectric barrier discharge lamp 1 of FIG. 16. FIG. 18 is an enlarged view of the measured data of the section Z roughly shown in FIG. 17. FIG. 19 illustrates the discharge current waveform $I_d(t)$ obtained by analyzing the waveforms shown in FIG. 18 with a computer, together with the voltage waveform $E(t)$ and the current waveform $I_s(t)$.

[0064] The following are the analytical conditions and experimental conditions in the case of FIGS. 17, 18 and 19.

C1: 35 pF

C2: 220 pF

C3: 15 pF

Frequency: 36 kHz

Transformer primary inductance: 33 μ H

Transformer secondary inductance: 6.1 mH

Transformer coupling coefficient: 0.9930
Dielectric: silica glass – 1 mm thickness
Discharge gas: xenon – 33 kPa pressure
Discharge gap: 4.3 mm

[0065] In FIG. 19, the discharge current waveform $I_d(t)$ sharply rises in two points of the time T_{d1} and the time T_{d2} . This shows that discharge started at the points. In the voltage waveform $E(t)$, inflection points K1 and K2 are formed at respective points corresponding to the time T_{d1} and the time T_{d2} , respectively. Among the two inflection points, although the inflection point K2 is relatively indistinct, the discharge current waveform $I_d(t)$ steeply rises at the time T_{d2} , and thereby the inflection point can be distinguished. When the voltage waveform $E(t)$ is viewed in more detail, inflections points K3 and K4 similar to the inflection point K2 are found at time T_{d3} and T_{d4} , respectively. The discharge current waveform $I_d(t)$ also shows that discharge started at the points K3 and K4.

[0066] If the value of V_y/V_x is calculated based on the conditions recited in claim 1 of the present application, according to FIG. 19, the value V_y/V_x for the discharge started at the time T_{d1} can be calculated by using the values: $V_f = V_{k4}$, $V_k = V_{k1}$, $V_b = V_{b1}$, and $V_h = V_{h1}$. In the same manner, the value for the discharge started at the time T_{d2} can be calculated by using the values: $V_f = V_{h1}$, $V_k = V_{k2}$, $V_b = V_{k2}$, and $V_h = V_{h2}$. Further, the value for the discharge started at the time T_{d3} can be calculated by using the values: $V_f = V_{h2}$, $V_k = 0$, $V_b = 0$, and $V_h = V_{h2}$. The value for the discharge started at the time T_{d4} can be calculated by using the values: $V_f = V_{h3}$, $V_k = V_{k4}$, $V_b = V_{k4}$, and $V_h = V_{k4}$. However, if contribution of each of the four discharge points to the whole discharge is judged from the area defined by the discharge current waveform $I_d(t)$ and the straight line of $I_d = 0$, the main discharge which substantially controls the efficiency is regarded as the discharge started at the time T_{d2} ; thus the other discharge points can be disregarded. Therefore, the value " $V_y/V_x = 0.32$ " is obtained for the whole of the waveform.